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ABSTRACT

This document contains an introduction to the Ohio Integrated Technical and Academic Competency (ITAC) and Specialization ITAC; an overview of the electrical trades; a list acknowledging professionals who helped develop the competency list; and the comprehensive list of professional or occupational competencies deemed essential for graduates to be able to perform proficiently when they graduate from an Ohio specialization workforce development program for the electrical trades. The introduction explains the following: (1) critical academic, employability, and information technology skills have been integrated throughout the list to support the technical skills; (2) the competency profile can be used as the basis for curriculum development in Ohio's secondary, adult, and postsecondary programs; and (3) the specialization competency profile is organized so that it can be clustered or grouped in a modular approach. The overview of the electrical trades describes general duties, some specific tasks, employment opportunities, length of program, type of program (classroom instruction and/or work experience), and types of certificates and/or degrees. The competencies are grouped under broader skills that are, in turn, categorized under these 13 major topics: orientation to the electrical trades industry; safety in the electrical trades industry; mathematics in electrical trades; computer applications in electrical trades; electrical principles and theory; National Electrical Code and other applicable codes; test equipment; electrical blueprints; fasteners and anchors; residential installations; commercial and industrial installations; commercial and industrial motor installations; and specialized systems. (YLB)

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Acknowledgements

Overview

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Introduction to the Specialization ITAC

Revised 2001

The Ohio Integrated Technical and Academic Competency (ITAC) profiles are developed under the auspices of the Ohio Department of Education and the Ohio State Board of Education. They provide a broad-based educational response to Ohio's need for a skilled workforce. Each Specialization ITAC represents a profile of the professional or occupational competencies deemed essential for a graduate to perform proficiently when he or she graduates from the specialization workforce development programs in Business and Marketing, Industrial and Engineering Systems, Health Occupations, or Family and Consumer Sciences. The Specialization ITAC profile, in conjunction with the competencies identified in the Foundation and Clusters ITACs, provide a career pathway that can lead to employment or further education.

Process and Intent

The integrated competency lists are the result of all encompassing research and review of existing competency profile lists and includes input from industry, labor, professional organizations, professional and industrial representation, and national standards for a specific industry/profession. Representatives from a broad cross-section of Ohio professional organizations, businesses/professions, industry, and labor played a critical role in identifying current and future knowledge and skills for the industry, and defining the vision and scope of the profession/industry. The instructional methods and teaching strategies are the responsibility of the local school system and/or instructor.

Curriculum Applications Using the ITAC Competency Profiles

Each profile includes a comprehensive listing of occupational skill competencies that reflect the job opportunities and skills that are required to work in a specific profession/career pathway. Critical academic, employability and information technology skills have been integrated throughout the list to support the technical skills. These competency profiles will be used as the basis for curriculum development in Ohio's secondary, adult, and post-secondary programs. The specialization competency profiles are organized so that they can be clustered or grouped in a modular approach. Individual curriculum specialists can use the competencies profiles to develop instructional programs based on local needs as determined in conjunction with their local advisory committees. i.e., the specialization cluster academy approach. Final assessments will be designed to accompany each profile list and to accommodate student evaluation by modules.

Career Pathways | FasTrak ITACs

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Office of Career-Technical and Adult Education
2001 Revision

Electrical Trades

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Electrical Trades

The two major kinds of careers in electricity are as electricians and as electrical engineers. Electricians are skilled draftspersons who install, maintain and repair electrical equipment. Electrical engineers design electrical apparatus or do research for industrial firms and colleges. An electrical engineer needs a college degree. Persons interested in such a career should study algebra, geometry, trigonometry, physics, and chemistry in high school. A person interested in a career as an electrician should take algebra and as many of these courses as possible. It is then possible to attend a technical school for further training and specialization. An aptitude for math and science, good color vision, and attention to detail are characteristics that lead to success in the industry.

Many people continue learning the electrical trade after a career-education program by completing a four or five-year apprenticeship program. The National Joint Apprenticeship and Training Committee (NJATC) has developed what perhaps is the largest apprenticeship and training program of its kind. This is a joint program between the National Electrical Contractors Association and the International Brotherhood of Electrical Workers.

Electricity is essential for light, power, for manufacturing operations, air-conditioning, and refrigeration. Electricians install, connect, test, and maintain electrical systems for a variety of purposes, including climate control, security, and communications. They also may install and maintain the electronic controls for machines in business and industry.

Employment in the Electrical Trades industry can take many different directions: electrical drafters, electrical engineering technicians, electrical engineers, electrical parts reconditioners, electrical power-line installers and repairers, electrical engineering technicians, electrical equipment assemblers, electrical inspectors and testers, electrical installers and repairers of commercial and industrial equipment, transportation or powerhouse/substation and relay stations, sales representative, etc. It ranks as one of the ten largest construction occupations. Job opportunities for skilled electricians are expected to be very good as the growth in demand outpaces the supply of workers trained in this craft. There is expected to be a shortage of skilled workers during the next decade because of the anticipated smaller pool of young workers entering training programs.

27.00.00.0 Electrical Trades

27.01.00.0 Orientation to the Electrical Trades Industry

27.01.01.0 Define the industry

27.01.01.01 Outline the scope of the electrical trades industry in the free enterprise system
27.01.01.02 Identify the professional and/or trade associations related to the electrical trades industry
27.01.01.03 Identify areas of specialization within the electrical trades industry
27.01.01.04 Analyze trends in the electrical trades industry
27.01.01.05 Identify the employment opportunities in the electrical trades industry
27.01.01.06 Identify how electricity is used in the construction industry

27.01.02.0 Determine skills needed to work in the industry

27.01.02.01 Match electrical trades occupational job titles with qualifications and responsibilities
27.01.02.02 Identify education and training required to work in various electrical trades careers
27.01.02.03 Describe the work techniques, processes, and procedures a typical electrical trades worker might be called on to perform
27.01.02.04 Describe the motor skills and mechanical aptitude needed to work in the electrical trades industry

27.02.00.0 Safety in the Electrical Trades Industry

27.02.01.0 Practice Lab Safety

27.02.01.01 Follow Occupational Safety and Health Administration (OSHA) standards as they relate to the electrical trades industry for job site safety
27.02.01.02 Explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job
27.02.01.03 Report unsafe conditions in accordance with Occupational Safety and Health Administration (OSHA) guidelines
27.02.01.04 Obtain OSHA ten-hour certification
27.02.01.05 Explain the purpose Material Safety Data Sheets (MSDS)
27.02.01.06 Follow safety procedures as outlined on MSDS
27.02.01.07 Use Material Safety Data Sheets (MSDS) to identify and properly handle hazardous materials (e.g., cleaning fluids, transformer oils)
27.02.01.08 Follow manufacturer's recommendations for the safe use of chemical products
27.02.01.09 Identify established procedures/regulations for storing/handling hazardous materials
27.02.01.10 Dispose of hazardous materials in accordance with Environmental Protection Agency (EPA) standards
27.02.01.11 Identify location of fire extinguishers and fire exits
27.02.01.12 Explain the proper use of the four classes of fire extinguishers
27.02.01.13 Conduct routine inspections of safety and fire equipment
27.02.01.14 Demonstrate established procedures for use of fire extinguishers
27.02.01.15 Identify potential health hazards in the lab/on the job site
27.02.01.16 Obtain first aid certification
27.02.01.17 Obtain CPR Certification
27.02.01.18 Identify the procedures for responding to a medical emergency
27.02.01.19 Lift/transport objects and materials in accordance with established safety practices
27.02.01.20 Identify consequences of disregarding safety rules

27.02.02.0 Handle tools in accordance with established safety procedures

27.02.02.01 Use safety apparatus and equipment in accordance with job requirements and safety standards
27.02.02.02 Handle all tools according to manufacturer's specifications regarding safe use (i.e., hand and power
27.02.02.03 Wear personal protective equipment, safety gear and clothing appropriate for given job
27.02.02.04 Document routine inspections of tools and power equipment
27.02.02.05 Interpret instructional manuals for safe operation of power tools and power equipment
27.02.02.06 Maintain safety guards and switches on all machinery
27.02.02.07 Shut down power in dangerous/emergency situations using power-kill switches

27.02.03.0 Demonstrate knowledge of safety procedures related to working with electricity

27.02.03.01 Describe effects of varying degrees of electricity on the human body
27.02.03.02 Demonstrate knowledge of local codes and National Electrical Code (NEC)
27.02.03.03 Select personal protective equipment (PPE) required for given tasks
27.02.03.04 Use PPE in accordance with requirements
27.02.03.05 Identify the guidelines governing fall protection
27.02.03.06 Comply with fall-protection guidelines
27.02.03.07 Identify/comply with the guidelines governing work in confined spaces
27.02.03.08 Use ladders and scaffolds in accordance with established safety procedures
27.02.03.09 Comply with the electrical safety requirements for the job site, including the use and types of Grand Fault Circuit Interrupter (GFCI) protection for personnel (i.e., document inspection)
27.02.03.10 Demonstrate knowledge of the safety procedures for excavating, trenching, and shoveling
27.02.03.11 Identify/comply with lock-out/tag-out procedures

27.02.04.0 Protect workers from ergonomic injuries

27.02.04.01 Identify work practices that insure healthy ergonomic practices
27.02.04.02 Identify repetitive motion activities that might cause injury
27.02.04.03 Maintain posture to prevent injuries

27.03.00.0 Mathematics in Electrical Trades

27.03.01.0 Apply technical related basic mathematics skills

27.03.01.01 Solve problems involving fractions
27.03.01.02 Convert decimals to fractions and fractions to decimals
27.03.01.03 Measure angles and sides of triangles
27.03.01.04 Determine unknown angles and sides of triangles
27.03.01.05 Use powers of ten to perform math functions
27.03.01.06 Use square root to solve problems

27.03.02.0 Solve mathematical problems related to electricity

27.03.02.01 Solve word problems involving whole numbers, fractions, and decimals
27.03.02.02 Convert metric prefixes to their numerical equivalents and vice-versa
27.03.02.03 Convert numbers to scientific notation
27.03.02.04 Solve algebraic and trigonomic formulas pertaining to electrical applications
27.03.02.05 Solve problems involving percentage, ratio, and proportion
27.03.02.06 Solve problems using direct and inverse relationships
27.03.02.07 Measure distance using scales and measuring devices
27.03.02.08 Use calculator to solve electrical problems
27.03.02.09 Interpret charts, graphs, and schematics

27.04.00.0 Computer Applications in Electrical Trades

27.04.01.0 Describe personal computer operations

27.04.01.01 Describe how data is stored in main computer memory
27.04.01.02 Recognize data storage techniques
27.04.01.03 Identify types of memory
27.04.01.04 Demonstrate computer keyboard skills

27.04.02.0 Use software

27.04.02.01 Define software types and functions
27.04.02.02 Describe basic disk operations and care
27.04.02.03 Describe industry specific applications (e.g., P.L.C. Energy Management)

27.05.00.0 Electrical Principles and Theory

27.05.01.0 Demonstrate knowledge of scientific laws related to electricity

27.05.01.01 Explain what atoms are, how they are constructed, and their relationship to electricity
27.05.01.02 Describe the relationship between electrical and magneto electric effect
27.05.01.03 Describe the photoelectric effect
27.05.01.04 Describe the thermocouple effect
27.05.01.05 Describe the thermoelectric effect
27.05.01.06 Describe the piezoelectric effect
27.05.01.07 Describe the turboelectric effect
27.05.01.08 Describe the electro chemical effect
27.05.01.09 Describe principles of harmonics
27.05.01.10 Describe the electrical effect of friction
27.05.01.11 Identify sources of electricity
27.05.01.12 Identify potential sources of electricity
27.05.01.13 Describe the differences between alternating current/direct current (AC/DC)
27.05.01.14 Define voltage and identify the ways in which it can be produced
27.05.01.15 Explain the difference between conductors and insulators
27.05.01.16 Define the units of measurement that are used to measure the properties of electricity
27.05.01.17 Explain how voltage, current, and resistance are related to each other
27.05.01.18 Using the formula of Ohm's Law, calculate an unknown value
27.05.01.19 Explain the different types of meters used to measure voltage, current, and resistance.
27.05.01.20 Using the power formula, calculate the amount of power used by a circuit

27.05.02.0 Apply Basic Electrical Theory

27.05.02.01 Explain the relationship of electron theory to circuit design by the use of Ohm's law
27.05.02.02 Demonstrate knowledge of uses of series, parallel, and series-parallel circuits including trouble-shooting skills
27.05.02.03 Identify types and uses of transformers and motors
27.05.02.04 Explain principles of magnetism/electromagnetism
27.05.02.05 Examine basic AC theory
27.05.02.06 Analyze alternating current

27.05.03.0 Analyze alternating current (AC)

27.05.03.01 Construct series AC resistive circuits for analysis
27.05.03.02 Construct parallel AC resistive circuits for analysis
27.05.03.03 Construct series-parallel AC resistive circuits for analysis
27.05.03.04 Evaluate voltage, current, frequency, and phase relative to the sine wave
27.05.03.05 Explain principles of transformers
27.05.03.06 Identify the characteristics of inductors in series and parallel circuits
27.05.03.07 Identify the characteristics of capacitors in series and parallel circuits
27.05.03.08 Evaluate resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
27.05.03.09 Evaluate true power, apparent power, reactive power, and power factor
27.05.03.10 Evaluate impedance
27.05.03.11 Measure current, voltage, and resistance in AC circuits
27.05.03.12 Explain simple AC generator action
27.05.03.13 Explain simple AC motor action

27.06.00.0 National Electrical Code (NEC) and Other Applicable Codes

27.06.01.0 Demonstrate knowledge of the organization of the NEC

27.06.01.01 Describe the purpose of the National Fire Protection Association (NFPA)
27.06.01.02 Explain the purpose and history of the National Electrical Code (NEC)
27.06.01.03 Describe the scope of NEC and local codes
27.06.01.04 Describe how local codes may differ from NEC
27.06.01.05 Demonstrate use of code books (e.g. mandatory rules, fine print rules, neat and workmanlike, locate definitions, interpretations, recognize and use exceptions, materials recognized by the NEC, identify code markings, distinguish wet, damp and dry locations, determine if specific installations are acceptable to the Code, requirements for special occupancies and special equipment and answer specific questions)

27.06.02.0 Apply commonly used articles of the NEC and other applicable codes (i.e., BOCA, OBBC, Life Safety Codes)

27.06.02.01 Use NEC to calculate various general job requirements (e.g. service conductors, feeders, branch circuits, permissible loads on various circuits, allowable cable tray fills, ampacity of various conductors and fill situations, ampacity of various circuits and load types, overload protection for motors, equipment and phase converters, minimum ampacity for motor disconnecting means, horsepower ratings for motors and disconnecting means, and grounding requirements)
27.06.02.02 Use NEC for hazardous locations (e.g. hazardous locations by Class, equipment and wiring methods necessary for particular hazardous locations)
27.06.02.03 Describe the purpose of the National Electrical Manufacturers' Association (NEMA)
27.06.02.04 Explain the role of testing laboratories (i.e., Universal Laboratory (UL), CSA, ITS)

27.07.00.0 Test Equipment

27.07.01.0 Use test equipment

27.07.01.01 Identify safety techniques established for the use of test equipment
27.07.01.02 Measure voltage using a voltage tester (e.g., Wiggins)
27.07.01.03 Measure current using a clamp-on ammeter
27.07.01.04 Measure voltage, current, and/or resistance using an analog multimeter
27.07.01.05 Measure voltage, current, and/or resistance using a digital multimeter
27.07.01.06 Verify installation using a receptacle polarity tester
27.07.01.07 Verify the operation of a ground-fault circuit interrupter using a GFCI tester

27.07.02.0 Identify applications of electrical testing equipment

27.07.02.01 Identify safety techniques established for the use of advanced test equipment
27.07.02.02 Demonstrate the operation of an ammeter
27.07.02.03 Demonstrate the operation of a wattmeter
27.07.02.04 Demonstrate the operation of a continuity tester
27.07.02.05 Demonstrate the use of recording Instruments
27.07.02.06 Demonstrate the use of cable-length meters
27.07.02.07 Demonstrate the use of a megohmmeter
27.07.02.08 Demonstrate the use of a potentiometer
27.07.02.09 Demonstrate the use of an oscilloscope
27.07.02.10 Demonstrate the use of a phase-rotation meter
27.07.02.11 Demonstrate the use of a circuit tracer
27.07.02.12 Demonstrate the use of a tic tester
27.07.02.13 Demonstrate the use of a light meter
27.07.02.14 Explain how to read and convert from one scale to another using the test equipment listed above
27.07.02.15 Explain the importance of proper meter polarity

27.08.00.0 Electrical Blueprints

27.08.01.0 Read electrical blueprints

27.08.01.01 Explain the basic layout of a blueprint
27.08.01.02 Describe the information included in the title block of a blueprint
27.08.01.03 Identify the types of lines used on blueprints
27.08.01.04 Interpret dimension, symbols, views, and scales
27.08.01.05 Understand the use of architect's and engineer's scales
27.08.01.06 Read equipment schedules found on electrical blueprints
27.08.01.07 Describe the type of information included in electrical specifications

27.08.02.0 Interpret electrical blueprints

27.08.02.01 Interpret electrical drawings, including site plans, floor plans, and detail drawings
27.08.02.02 Locate sites for installation
27.08.02.03 Identify layout for wiring runs

27.09.00.0 Fasteners and Anchors

27.09.01.0 Identify different types of fasteners and anchors

27.09.01.01 Identify and explain the use of threaded fasteners
27.09.01.02 Identify and explain the use of non-threaded fasteners
27.09.01.03 Identify and explain the use of anchors

27.09.02.0 Demonstrate various uses of fasteners and anchors

27.09.02.01 Demonstrate the correct application for fasteners and anchors
27.09.02.02 Install fasteners and anchors

27.10.00.0 Residential Installations

27.10.01.0 Install rough-in wiring

27.10.01.01 Follow specifications, drawings, and code requirements for rough-in wiring
27.10.01.02 Select materials in compliance with specifications, drawings, and code requirements
27.10.01.03 Lay out runs based on circuit requirements (i.e., three-ways, four-ways, home runs, and GFCI)
27.10.01.04 Locate/mount boxes
27.10.01.05 Install wiring between and in boxes
27.10.01.06 Identify/connect wiring in boxes
27.10.01.07 Install wiring underground
27.10.01.08 Arrange for rough-in inspections

27.10.02.0 Install service equipment

27.10.02.01 Install service entrance systems in accordance with customer and power company agreements
27.10.02.02 Verify that the location of service equipment is in compliance with NEC and utility requirements
27.10.02.03 Lay out service equipment
27.10.02.04 Install service panels and meter appurtenances
27.10.02.05 Install grounding electrode system, making all needed connections
27.10.02.06 Install sub panels, making all needed connections
27.10.02.07 Install/identify over current protective devices

27.10.03.0 Install finish wiring

27.10.03.01 Install lighting fixtures
27.10.03.02 Install wiring devices and covers
27.10.03.03 Connect appliances
27.10.03.04 Check/test installation
27.10.03.05 Arrange for final inspections
27.10.03.06 Identify panel directory

27.10.04.0 Install residential low-voltage systems

27.10.04.01 Install low-voltage communication and telephone systems
27.10.04.02 Install low-voltage control systems
27.10.04.03 Install low-voltage lighting systems
27.10.04.04 Service low-voltage systems

27.10.05.0 Verify residential installations following established trouble-shooting and repair procedures

27.10.05.01 Perform visual inspections
27.10.05.02 Refer to available wiring diagrams
27.10.05.03 Locate specific circuits
27.10.05.04 Check circuit connections
27.10.05.05 Repair/replace faulty components
27.10.05.06 Test systems

27.11.00.0 Commercial and Industrial Installations

27.11.01.0 Install rough-in wiring

27.11.01.01 Schedule necessary inspections
27.11.01.02 Verify on-site dimensions
27.11.01.03 Select materials in compliance with specifications, drawings, and code requirements
27.11.01.04 Follow specifications, drawings, and code requirements for rough-in wiring
27.11.01.05 Locate electrical boxes and panels
27.11.01.06 Install electrical boxes and panels
27.11.01.07 Lay out conduit or cable runs
27.11.01.08 Install raceways/cable systems e.g., EMT, GRC, IMC, PVC, ENT, AC, MC
27.11.01.09 Identify needed conductors according to specifications, drawings, and code requirements
27.11.01.10 Pull identified conductors using method appropriate for size and number of conductors
27.11.01.11 Install equipment grounding and bonding systems
27.11.01.12 Define cable tray

27.11.02.0 Make conductor terminations

27.11.02.01 Install wire nuts
27.11.02.02 Install mechanical connections, applying specified torque values
27.11.02.03 Install compression connections
27.11.02.04 Solder connections
27.11.02.05 Describe exothermic connections

27.11.03.0 Identify distribution systems

27.11.03.01 Verify that the location of service equipment is in compliance with NEC and utility requirements
27.11.03.02 Lay out distribution systems
27.11.03.03 Identify service equipment
27.11.03.04 Identify meter apparatus
27.11.03.05 Identify grounding-electrode systems, making all needed connections
27.11.03.06 Identify feeders, and all needed connections
27.11.03.07 Identify transformers and all needed connections
27.11.03.08 Identify metering equipment, panels, and disconnects, and all needed connections

27.11.04.0 Install finish wiring

27.11.04.01 Install wiring devices
27.11.04.02 Install lighting fixtures
27.11.04.03 Install equipment, making all needed connections
27.11.04.04 Label circuits and equipment per NEC

27.12.00.0 Commercial and Industrial Motor Installations

27.12.01.0 Install motors and power wiring in accordance with NEC

27.12.01.01 Interpret motor nameplate information and motor specifications on drawings
27.12.01.02 Wire single-phase and three-phase motors
27.12.01.03 Install motor controllers
27.12.01.04 Wire motors to motor controllers
27.12.01.05 Verify motor rotation

27.12.02.0 Install motor control wiring

27.12.02.01 Interpret schematics and control diagrams
27.12.02.02 Select wire, control and safety devices in accordance with schematics and control diagrams
27.12.02.03 Verify operation and rotation

27.12.03.0 Describe operation of programmable controllers

27.12.03.01 Interpret terms associated with programmable controllers
27.12.03.02 Demonstrate knowledge of programmable-controller ladder-logic program

27.13.00.0 Specialized Systems

27.13.01.0 Identify various types of data/communication systems

27.13.01.01 Identify local, state, and NEC requirements for the installation of security and fire alarms
27.13.01.02 Identify energy management systems according to manufacturer's specification
27.13.01.03 Identify SMART HOUSE systems
27.13.01.04 Identify fiber-optic systems

27.13.02.0 Identify installation techniques for each system

27.13.02.01 Identify installation techniques for security and fire alarm systems
27.13.02.02 Identify installation techniques for energy-management systems
27.13.02.03 Identify installation techniques for SMART HOUSE systems
27.13.02.04 Identify installation techniques for fiber-optic systems
27.13.02.05 Identify installation techniques for wiring systems
27.13.02.06 Identify conductor types